

**IMPROVING HEAVY EQUIPMENT DUMP TRUCK HD785-7 FUEL RATIO BY
USING EXPLORATORY DATA ANALYSIS METHOD**

By

MOCHAMMAD ERFAN PRASETYO

22452021

MASTER'S DEGREE

in

MECHANICAL ENGINEERING - ENGINEERING MANAGEMENT
FACULTY OF ENGINEERING AND INFORMATION OF TECHNOLOGY



SWISS GERMAN UNIVERSITY

The Prominence Tower, Alam Sutera

Jalan Jalur Sutera Barat No.15 Tangerang 15143

Indonesia

Revision After The Thesis Défense on August 15th, 2025

STATEMENT BY THE AUTHOR

I hereby declare that this submission is my own work and to the best of my knowledge, if contains no material previously published or written by another person, nor material which to a substantial extent has been accepted for the award of any other degree or diploma at my educational institution, except where due acknowledgement is made in the thesis.

Mochammad Erfan Prasetyo, S.T.

Student



Date : August 22th, 2025

Approved by:

Dr. Yunita Umniyati, S.Si., M.Sc.

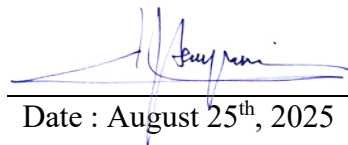
Thesis Advisor



Date : August 25th, 2025

Assoc. Prof. Dr. Ir. Henry Nasution, S.T., M.T., IPP.

Thesis Co-Advisor



Date : August 25th, 2025

Dr. Ir. Maulahikmah Galinium, S.Kom., M.Sc.

Dean of Faculty of Engineering &
Information Technology

Date : August 26th, 2025

Mochammad Erfan Prasetyo

ABSTRACT

**IMPROVING HEAVY EQUIPMENT DUMP TRUCK HD785-7 FUEL RATIO BY
USING EXPLORATORY DATA ANALYSIS METHOD**

By

Mochammad Erfan Prasetyo, S.T.

Dr. Yunita Umniyati, S.Si., M.Sc., Advisor

Assoc. Prof. Dr. Ir. Henry Nasution, S.T., M.T., IPP., Co-Advisor

SWISS GERMAN UNIVERSITY

This thesis investigates the improvement of fuel efficiency for Komatsu HD785-7 dump truck at PT XYZ by employing Exploratory Data Analysis (EDA) method. The objective is to reduce the fuel ratio from 0.17 to 0.15, addressing operational inefficiencies that have been identified as a significant issue. The research utilizes the DMAIC framework, to guide the analysis and implementation of solutions. Data collection encompasses three main categories: manpower, equipment condition, and operational data, which analysed to identify patterns and root causes. The study employs statistical methods, including SHAP and PDP, to interpret data and assess the impact of different variables on fuel consumption. The results indicate that improvements in operator, equipment, and operational strategies can enhance fuel efficiency. The implementation of a cloud-based data architecture using Google Cloud Platform. The quantitative results for selected dump trucks showed 10% higher payload per cycle, 37% higher refuelling quantity, and a 23% reduction in fuel ratio. This led to a conservative profit increase for PT XYZ of over IDR 1.2 billion per month for four units. This research successfully demonstrates how a data-driven EDA approach combined with the DMAIC framework can optimize fuel consumption in heavy-duty dump truck, delivering substantial operational and financial benefits.

Keywords : HD785-7, Fuel Ratio, Exploratory Data Analysis, SHAP Value, PDP, DMAIC.

COPYRIGHT PAGE

© Copyright 2025

By Mochammad Erfan Prasetyo

All right reserved



DEDICATION

I dedicate this thesis to my beloved family: my wife, Windha, and my two little kids, Arkhan and Hafidz, for their endless love, patience, and unwavering support throughout my studies. To my parents, thank you for your constant blessings and prayers. To all my

MME lecturers and my college friend, I am deeply grateful for the knowledge and perspectives you have shared, which have greatly shaped my way of thinking. And to my beloved company, thank you for the opportunity to pursue one of my goals and turn a dream into reality.



ACKNOWLEDGMENTS

I would like to express my sincere gratitude to the entire committee for their support, guidance, and valuable interactions throughout the process of completing this thesis. The motivation and direction provided have been truly meaningful and deeply appreciated.

My deepest thanks go to **Dr. Yunita Umniyati, S.Si., M.Sc.**, as my Thesis Advisor, for her continuous guidance, constructive feedback, and encouragement that helped shape this thesis into its final form. I am also very grateful to **Assoc. Prof. Dr. Ir. Henry Nasution, S.T., M.T., IPP**, as my Thesis Co-Advisor, for his insights and thoughtful direction in enhancing the substance and structure of my research.

I would also like to extend my appreciation to **Dr. Ir. Gembong Baskoro, M.Sc., IPU, ACPE, APEC Eng.**, as the Head of the Master of Mechanical Engineering Program, for his leadership and dedication in developing a high-quality academic environment. My appreciation also goes to **Dr. Ir. Maulahikmah Galinium, S.Kom., M.Sc.**, as the Dean of the Faculty of Engineering and Information Technology, for her support throughout my academic journey.

During my study in the Master of Mechanical Engineering program, especially in the field of Engineering Management, I have gained invaluable knowledge and a rich learning experience through an internationally oriented curriculum and academic atmosphere.

May the knowledge and experience I have acquired serve as a foundation to enhance my potential and allow me to contribute meaningfully to my family, company, nation, and country.

TABLE OF CONTENTS

STATEMENT BY THE AUTHOR	2
ABSTRACT	3
COPYRIGHT PAGE	4
DEDICATION	5
ACKNOWLEDGMENTS	6
TABLE OF CONTENTS.....	7
LIST OF FIGURE	9
LIST OF TABLE.....	11
CHAPTER 1. INTRODUCTION.....	12
1.1. Background	12
1.2. Research Problems	17
1.3. Research Objectives.....	17
1.4. Significance of Study.....	17
1.5. Research Questions.....	17
1.6. Hypothesis.....	18
CHAPTER 2 : LITERATURE REVIEW	19
2.1 Coal Mining Industry in Indonesia.....	19
2.1.1 Heavy Equipment in Coal Mining Production.....	19
2.1.2 Heavy Equipment Productivity in Mining.....	24
2.1.3 Overview of key performance metrics	25
2.1.4 Factors affecting dump truck Fuel Ratio	25
2.2 Exploratory Data Analysis (EDA).....	27
2.2.1 Definition and Purpose of EDA in Uncovering Data Patterns.....	27
2.2.2 Applications of EDA in operational and equipment analytics.....	28
2.2.3 Overview of Exploratory Data Analysis Model Development	29
2.3 Previous Study.....	35
CHAPTER 3 : RESEARCH METHODS	41
3.1 Scope of Study.....	41
3.2 Research Framework	41
3.2.1 Define.....	41
3.2.2 Measure.....	43

3.2.3 Analyse	48
3.2.4 Improve	50
3.2.5 Control	51
CHAPTER 4: RESULT AND DISCUSSION	53
4.1 Data Collection.....	54
4.2 Data Validation.....	55
4.3 Data Analysis	69
4.3.1 First Iteration	71
4.3.2 Second Iteration.....	80
4.3.3 Third Iteration	83
4.3.4 Root Cause Prioritization and Potential Solution Design.....	84
4.4 The Result	87
4.4.1 Intervention 1 : Maximizing Payload	87
4.4.2 Intervention 2 : Minimizing Refuel Round.....	89
4.4.3 Final Result	91
CHAPTER 5: CONCLUSIONS AND RECOMMENDATIONS	94
5.1 Conclusion.....	94
5.2 Recommendation	94
CURRICULUM VITAE.....	100

LIST OF FIGURE

Figure 1. 1 Revenue Contribution PT ABC.....	12
Figure 1. 2 Coal Price Trend in Last 5 Year	13
Figure 1. 3 Net Zero Emission Target in Indonesia	13
Figure 1. 4 Total Cost of Ownership of Heavy Equipment	14
Figure 1. 5 Fuel Ratio Distribution Among PT ABC Customer	15
Figure 1. 6 Dump Truck Production Result.....	16
Figure 1. 7 Fuel Consumption Plot of HD785-7 in PT XYZ.....	16
Figure 2. 1 Open Pit Mining Overview	19
Figure 2. 2 Operation Mode in HD785-7.....	20
Figure 2. 3 Retarder Function in HD785-7	21
Figure 2. 4 ARSC Mode on HD785-7	22
Figure 2. 5 Mode Selection on PC2000-8.....	22
Figure 2. 6 Komtrax – Plus on Heavy Equipment	23
Figure 2. 7 Komatsu HD785-7 Payload Policy.....	24
Figure 2. 8 Example of EDA to Determine Important Feature	28
Figure 2. 9 EDA for Refuelling in Coal Mining Operation	28
Figure 3. 1 DMAIC Process.....	41
Figure 3. 2 Project Team Structure.....	43
Figure 3. 3 High Level Process Map	43
Figure 3. 4 Man Power Theory Example.....	46
Figure 3. 5 Equipment Theory Example.....	47
Figure 3. 6 Operation Theory Example	47
Figure 4. 1 Solution Architecture	53
Figure 4. 3 Equipment Unit Breakdown Data Cleansing	60
Figure 4. 4 Daily Production Report (DPR) Data Cleansing	61
Figure 4. 5 Environment Data Cleansing.....	62
Figure 4. 6 Oil Consumption Data Cleansing	63
Figure 4. 7 Operator Training Data Cleansing.....	64
Figure 4. 8 Operator Vehicle HM Data Cleansing	64
Figure 4. 9 Operator Data Cleansing	65
Figure 4. 10 : Populasi Unit Data Cleansing.....	66
Figure 4. 11 : Refuelling Data Cleansing.....	67
Figure 4. 12 : Timesheet Data Cleansing.....	68
Figure 4. 13 : Vessel Data Cleansing.....	68
Figure 4. 14 : Granularity Data vs Event	70
Figure 4. 15 : SHAP Value Example and How to Interpreted.	72
Figure 4. 16 : SHAP Value for 1 st iterations	72
Figure 4. 17 : SHAP PDP Interpretation.....	75
Figure 4. 18 : What If Scenario on PDP	75
Figure 4. 19 : PDP of Oil Temperature & Pressure.....	76
Figure 4. 20 : PDP of Fill Time.....	77
Figure 4. 21 : PDP of Payload Type	78

Figure 4. 22 : PDP of Road Gradient.....	78
Figure 4. 23 : PDP of Oil Change.....	79
Figure 4. 24 : PDP of Operator Age and Training	79
Figure 4. 25 : PDP of Transmission Oil.....	80
Figure 4. 26 : PDP of Fault Codes.....	80
Figure 4. 27 : Payload Distribution for Each Vessel Type	81
Figure 4. 28 : Payload Distribution per Ritage.....	82
Figure 4. 29 : Distribution of Refuel Quantity.....	82
Figure 4. 30 : Field Observation Result.....	83
Figure 4. 31 : Boxplot Explanation	85
Figure 4. 32 : SOP for Maximizing Payload for Target Fleet.....	85
Figure 4. 33 : SOP for Efficient Refuelling of Target Fleet	86
Figure 4. 34 : Cycle Level Report on Payload for Dump Truck ID 4177	87
Figure 4. 35 : Cycle Level Report on Payload for Dump Truck ID 4145	87
Figure 4. 36 : Cycle Level Report on Payload for Dump Truck ID 4257	88
Figure 4. 37 : Cycle Level Report on Payload for Dump Truck ID 4152	88
Figure 4. 38 : Refuel Round Level Report for Refuel Quantity for Dump Truck ID 4177	89
Figure 4. 39 : Refuel Round Level Report for Refuel Quantity for Dump Truck ID 4145	90
Figure 4. 40 : Refuel Round Level Report for Refuel Quantity for Dump Truck ID 4257	90
Figure 4. 41 : Refuel Round Level Report for Refuel Quantity for Dump Truck ID 4152	91
Figure 4. 42 : Daily Reporting for Ritage.....	91
Figure 4. 43 : Daily Reporting for Cycle Payload.....	92
Figure 4. 44 : Intervention impact on Fuel Ratio	92

LIST OF TABLE

Table 4. 1 Data Collection	54
Table 4. 2 Mine and Road Condition Theory	56
Table 4. 3 Equipment Theory.....	57
Table 4. 4 Operator Theory	59
Table 4. 5 Data Type Comparison.....	70
Table 4. 6 Summary Iteration of Model	72
Table 4. 7 Key Insight and Potential Impact on Fuel Ratio	74
Table 4. 8 Key Insight and Potential Intervention.....	84

